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Determination of Stresses and Deformation During Measurements with Loading Method on Central Ore Pillars in TREPCA Mine

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Abstract: The most rational mean of using ore body in TREPCA mine is to put security pillars from the ore, these pillars have square cross section size at starter 10×10 m. This way of formation of pillars is done utilizing central ore troops which have great amount of the ore body. Whether the pillars formed analyzed in terms of sustainability, we can state that they are stabile and they possess a high safety factor. We have to state that for the first time determination of stresses in pillars of ore is done in workshop 130 directly with method of measurements.

Key words: Mine, workshop, stress, deformation, measurement, TREPCA

INTRODUCTION

Ore extraction by an underground mining method involves the generation of different types of openings with a considerable range of functions (Brady and Brown, 2004). In TREPCA source, ore troops and rocks are without regular geometric form ore pillars are distributed with a schedule like chess figures in these workshops are stabile and sustainable up to 15-20 m distance and are shown in Fig. 1, where can be seen pillars in square cross section. There also can be seen galleries for transportation of minerals.

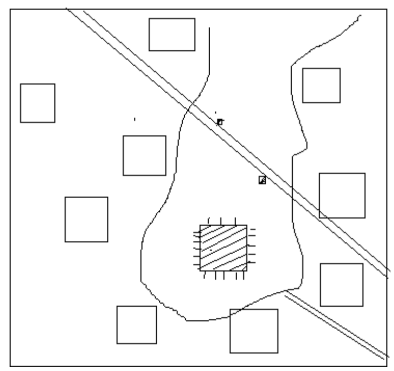

Fig. 1: Distributed form of central ore pillars

For greatest distance, we apply vertical pillars with square cross section from ore with dimensions 10×10 m and height depending from thickness of ore troop and that can be seen in Fig. 2. Is represented 3D form of pillars of ore? For calculation of stress and deformation in theory can be used method of finite elements (Zienkiewicz and Taylor, 2000) as it is shown in Fig. 2. Consequently, pillar strength has to be estimated on the basis of laboratory tests on rock samples and rock mass classification (Wagner, 2003), the effect of the width to height ratio on the strength of pillars with W/H>1 pillar strength has been estimated using Salamon's pillar strength formula:

$$\sigma_{Pillar} = C_{rock\,mass}(W^{0.46}/H^{0.60}) \quad (1)$$

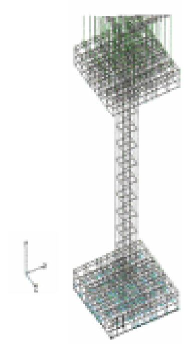

Fig. 2: Vertical form of the ore pillar

Where C rock mass is the strength of the rock mass according to Hoek and Brown. A measurement of deformation is done direct in the pillar. Exploitation method of ore in TREPCA is done by filling exploitation spaces that is good with Hydro saturation. In primary phase are used approximately 2/3 of ore whereas 1/3 remains for stability during the exploitation of ore and for safety of the workshop. The percentage of metal in ore is very important because such as these pillars are stronger. Secondary use is done in pillars that are on the horizon VII which have the highest quality of metal in ore.

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MATERIALS AND METHODS

Measurement of deformation and stresses: At the beginning is done measurement of deformation of the central ore pillar in the workshop 130 and after that verify dimensions 10×10 m which in the point of technological view are reasonable to use the ore.

The directly measurement of deformation and stresses in ore pillars is done with loading massive method, one part of ore massive around measuring point is released from the rest of the massive in order to have real deformation in the circumstances created (Fig. 3). The measurement is done in three phases. For accuracy of measurements results are developed 10 measurements of stresses and deformations in pillar of the workshop 130. In Fig. 4, initially is made boring in pillar in the side tool bar with diameter 51 mm and with depth 1800 mm, in this case the hole cleaning is done with water pressure from particles of ore. In place of drill electric probe is placed which is also fixed measurement instruments SR-4STRAIN INDIKATOR Type N which has three buttons and made possible readings of deformations (Institute of Mining, 1977). Initially is done drilling:

$$\varepsilon 1', \varepsilon 2' \text{ and } \varepsilon 3' \quad (2)$$

Probe during the drilling is placed in a position that direction of the first button comply with the direction of the axis, after that is done unloading of the ore masse around probe as it is in Fig. 3 by means of the aforementioned instrument read the values of deformation after removal of the ore massive for each button contact as shown in Fig. 5.

$$\varepsilon 1'', \varepsilon 2'' \text{ and } \varepsilon 3'' \quad (3)$$

Sizes of deformation for the three directions are:

$$\begin{aligned} \varepsilon 1 &= \varepsilon 1' - \varepsilon 1'' \\ \varepsilon 2 &= \varepsilon 2' - \varepsilon 2'' \\ \varepsilon 3 &= \varepsilon 3' - \varepsilon 3'' \end{aligned} \quad (4)$$

Fig. 3: Presentation of drilling the holes for measuring deformation

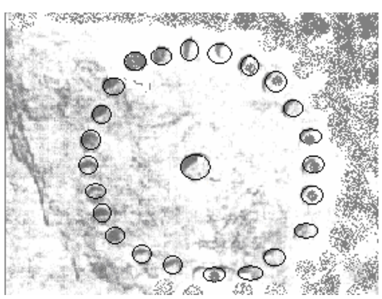

Fig. 4: Drilled holes in massive

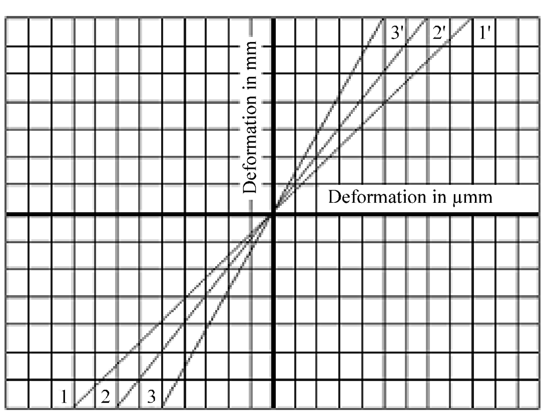

Fig. 5: Diagram of electrical probe

RESULTS AND DISCUSSION

Deformations ε1, ε2 and ε3 are determined by reading the diagram given by electric probe (Fig. 5). These results of deformation which can be seen in Table 1 are gained from electrical probe in different location.

Stresses results: Table 2 shows results of stress axial and main stress. Stresses are measured with daN/cm2 whereas the angle with degree. Stresses or strength of pillars are gained with calculation of formula (5-8) in function of deformation and ϕ (Clough, 1960).

Table 1: Results of deformation

Deformating reading (ε')	Location I (ε'')	Deformation (εμmm)
0.1000053400	0.100005850	51
20.100001922	0.100001951	29
3.0800174000	0.100001572	12
Deformating reading (ε')	Location II (ε'')	Deformation (εμmm)
10.100004550	0.100004820	27
20.100001538	0.100001579	41
30.120001690	0.120001910	22
Deformating reading (ε')	Location III (ε'')	Deformation (εμmm)
10.10003400	0.10000439	99
20.100001930	0.12000600	130
30.120003110	0.12000325	14

Table 2: Stresses in pillar massive

No. of measurements	σx	σy	σ1	σ2	ϕ
1	238.88	34.62	241.30	220.50	7.63
2	392.03	93.40	403.60	41.60	13.40
3	502.24	155.56	519.30	-183.10	14.50
4	222.33	93.01	241.30	33.30	22.70
5	462.67	260.07	520.10	-33.30	27.18
6	679.58	260.07	752.70	-297.50	30.90
7	268.26	251.91	368.30	-272.60	43.20

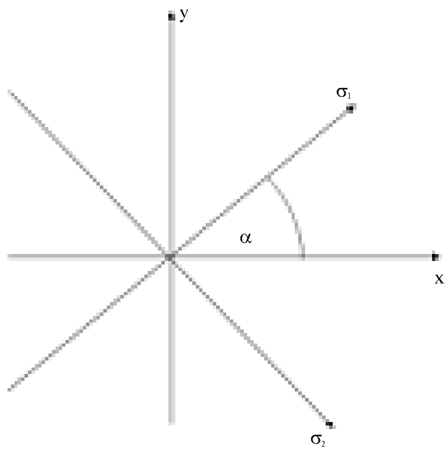

Fig. 6: Determination of the main directions

Main stresses:

$$\sigma_1 = \frac{E}{\sigma d}\left[(\varepsilon_1 + \varepsilon_2 + \varepsilon_3) + \sqrt{\frac{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2 + (\varepsilon_3 - \varepsilon_1)^2}{2}}\right] \quad (5)$$

$$\sigma_2 = \frac{E}{\sigma d}\left[(\varepsilon_1 + \varepsilon_2 + \varepsilon_3) - \sqrt{\frac{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2 + (\varepsilon_3 - \varepsilon_1)^2}{2}}\right] \quad (6)$$

$$\sigma_2 = \frac{E}{\sigma d}\left[(\varepsilon_1 + \varepsilon_2 + \varepsilon_3) \mp \sqrt{\frac{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2 + (\varepsilon_3 - \varepsilon_1)^2}{2}}\right] \quad (7)$$

Component of stresses:

$$\sigma x = \sigma 1 \cos\phi \quad (8)$$

Determination of the main directions are shown in Fig. 6.

CONCLUSION

Technical and economic parameters are sound in dimensions of holder existing pillars. According to the results, we can state that dimensions of holder pillars will manage to have stability of pillars, decrease of losses and different analysis of pillars section.

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